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Space Shuttle, Expendable Launch Vehicles

The International Space Station Program $2,114.5 million

The goal of the International Space Station (ISS) is to support activities requiring theunique attributes of humans in space and to establish a permanent human presence in Earth orbit. It provides a long-duration habitable laboratory for science and research activities, which allow investigation of the limits of human performance; vastly expand human experience in living and working in space; and provide the capability to encourage and enable commercial development of space.

The ISS will provide a capability to perform unique, long duration, space-based research in cell and developmental biology, plant biology, human physiology, fluid physics, combustion science, materials science and fundamental physics. ISS will also provide a unique platform for making observations of the Earth's surface and atmosphere, the sun, and other astronomical objects. The experience and dramatic results obtained from the use of the ISS will guide the future direction of the Human Exploration and Development of Space Enterprise, one of NASA's key strategic areas. The International Space Station is key to NASA's ability to fulfill its mission to explore, use, and enable the development of space for human enterprise.

Compared to the FY 2000 budget, the FY 2001 budget request reflects an overall reduction in the budget and runout estimates through FY 2005 of about $1.2 billion. Roughly $0.8 billion of this reduction is due to the movement of funding for the Phase 2 production of the ISS Crew Return Vehicle (CRV) to the Science, Aeronautics and Technology budget account. The FY 2002-2005 funding estimates will reside in that account pending a decision in the next two years on whether to proceed with an X-38-based CRV design, in the context of broader decisions that NASA and the Administration will make regarding future space transportation architectures. There was also an approximate $0.4 billion reduction in other ISS funding, largely implemented by reduced reserves.

Vehicle $442.6 million

The Boeing Company is the prime contractor for the design and development of the U.S. elements of the Station. It also has prime responsibility for the integration and assembly of all components provided by the United States and the International Partners. At its Huntington Beach, CA, facilities, Boeing is developing and constructing the integrated truss segments that anchor Station elements and house essential systems, including central power distribution, thermal dissipation and attitude control equipment. Other Boeing locations are also supporting the flight hardware built to augment capabilities at Huntington Beach. The Huntington Beach facility is also building other major components of the subsystems for communications and data handling, thermal control, guidance, and navigation and control.

The pressurized components provided by the United States are being built at Boeing's Huntsville, AL, facility. Four photovoltaic elements, each containing a mast, rotary joint, radiator, arrays and associated power storage and conditioning elements comprise the power system. These and the power truss segments and power system are being developed at Boeing's Canoga Park, CA, location. The development program also includes test, and manufacturing and assembly support for critical NASA center activities and institutional support. The U.S.-funded elements also include the Zarya energy block provided by a Russian firm under the Boeing prime contract. Other U.S. elements being provided through bilateral agreements include the pressurized logistics modules provided by the Italian Space Agency, Nodes 2 and 3 and the cupola provided by ESA, and the centrifuge accommodation module (CAM) and centrifuge provided by the Japanese.

Russia and the United States launched the first two elements of the International Space Station (Zarya and Unity) in the first quarter of FY 1999, and joined them together on orbit. Since that time, the ISS stack has completed over 6,400 orbits since the first two elements were successfully launched and mated. We have vigorously exercised the U.S.-led control teams along with our Russian partners as they worked anomaly resolution, avoidance maneuvers, an ISS reboost and the first docking with the International Space Station -- a logistics flight with almost two tons of supplies and equipment for the station.

The next assembly launch to the ISS was intended to be the Russian-built Service Module, providing the initial crew quarters. However, last year, Russia encountered two setbacks in the long history of over 250 Proton launches, 95% of which have been successful. A firm timeline of events leading to the launch of the Service Module is not expected to occur until mid-February when a General Designers Review will be conducted in Russia to address detailed plans. However, the Rosaviakosmos General Director, Mr. Koptev, has informed us that he believes the SM will not be launched until Summer 2000.

This delay in the SM launch is not anticipated to affect the vehicle budget in the near-term since contractor hardware delivery dates are being maintained. Some reallocation may become necessary as we move through the assembly sequence; the degree of impacts will be assessed over the coming months.

Given that the launch of the Service Module may not occur until this summer, NASA is doing the necessary preparations to prepare the Interim Control Module for launch in December 2000. The Interim Control Module provides attitude control and reboost functions needed for continuing station assembly until the Service Module, a replacement vehicle in the case of a SM launch failure, or U.S. Propulsion Module can be delivered to orbit. A decision would need to be made this summer to preserve this option of launching the module as activities to configure a specific Orbiter to launch would then need to proceed.

Pending forthcoming decisions from the General Designers Review regarding the timeline to launch the Service Module, NASA is also proceeding with plans to slightly alter and split the mission of STS-101, (ISS 2A.2), which was previously planned to rendevous with the orbiting ISS stack in December 1999. This mission could be refocused toward performing maintenance and hardware change-out of components so that FGB (Zarya) operational certification can be extended until the December 2000 timeframe, consistent with ICM contingency launch planning. Referred to as 2A.2a, this flight could be launched as early as April 2000. Should the Service Module be launched in Summer 2000, NASA would then launch the same orbiter, Atlantis, to support its initial mission of preparing the Service Module for the arrival of its first resident crew after the Service Module launch . This short turnaround for time for the second Atlantis flight, referred to as ISS 2A.2b, would be possible because the flight configurations will be maintained very near that of the initial mission.

U.S. assembly flights will resume following the launch of the Service Module. Specific decisions relative to the launch of the Service Module needed to develop a detailed assembly sequence will not be forthcoming for several weeks.

Should the Service Module be launched in the fourth quarter of FY 2000, a U.S logistic flight will follow shortly thereafter in preparation for the first crew.

Flight 3A is the next U.S. assembly flight. It will be launched 2-3 months after launch of the Service Module, placing it in late FY 2000 or early FY 2001. It will carry the Z-1 Truss Segment, Control Moment Gyros (CMG), the third Pressurized Mating Adapter (PMA-3), Ku-band and S-band equipment, and extravehicular activity subsystem (EVA) components. The Z-1 truss will provide a base for temporary installation of the P6 photovoltaic module to Node 1. That will provide U.S.-based electrical power early in the Station's assembly process. The Ku-band and CMGs will provide communication and attitude control so that scientific research can begin early in the Station's assembly process. PMA-3 will provide a Space Shuttle docking location for installation of the laboratory on flight 5A.

Soon after 3A the first crew, led by U.S. Commander William Shepherd, will be launched to orbit. The crew will arrive in a Soyuz spacecraft; it will remain attached to the Station and provide an emergency return capability for the crew. Permanent human presence aboard the International Space Station begins with this expeditionary crew. Their mission will set the stage for advanced research as crucial ISS assembly milestones are met during their stay.

Flight 4A will follow the 3A mission by 1-2 months. It includes the P6 Truss structure containing the long spacer, the Integrated Electronic Assembly (IEA), the P6 photovoltaic array, External Active Thermal Control System (EATCS) and additional S-band equipment. This launch will establish initial U.S. user capability by providing power generation and photovoltaic thermal control. The Ku-band equipment and CMGs will be activated on this flight.

By the mid point of FY 2001 the U.S. laboratory (Flight 5A) will be launched with five integrated systems racks and the Human Research Facility (HRF) rack. The capability to conduct research aboard the International Space Station will begin with delivery and outfitting of the HRF.

Other flights that will likely occur later in FY 2001, should the Service Module be launched in late FY2000 include: Flight 5A.1 which will continue the outfitting of the U.S. laboratory with six additional lab system racks and one HRF payload rack. The Italian-built Multi-Purpose Logistics Module (MPLM-1) will be used as the pressurized carrier for this hardware.

Flight 6A will continue the outfitting of the U.S. laboratory with the addition of two stowage and two EXPRESS payload racks. Also included are a UHF antenna and the Canadian Space Station Remote Manipulator System (SSRMS), the "arm" that will help with Station assembly. MPLM-2, will be used as the pressurized carrier on this flight. The UHF antenna will provide space-to-space communications capability for U.S.-based EVA, while the SSRMS will be used to perform assembly operations on future flights.

Flight 7A will feature the airlock. The addition of the airlock to the on-orbit stack permits ISS-based EVA without the loss of environmental consumables such as oxygen. Flight 7A completes Phase 2 of the International Space Station Program.

Flight 7A.1 is a logistics and utilization mission delivering resupply/return stowage racks, resupply stowage platforms and two EXPRESS payload racks. This flight will also carry critical spares and resupply items.

Operations Capability $826.5 million

Safety, reliability and sustainability are the principal objectives of the Operational Capability program. This includes planning, training, and flying the Space Station as well as the ground and transportation operations needed to do so. The second major objective is to carry out the program in a simplified and affordable manner. This includes NASA's overall integration of the operations of the International Partners. Space Station operations will rely on the expertise and infrastructure developed during the nearly 100 flights of the Space Shuttle, including the lessons learned from the Shuttle-Mir program. Finally, the contractor expertise is maintained through spares procurements and the transition of engineering workforce from development to operations as Space Station assembly proceeds.

While the Space Station flights described are taking place through FY 2000 and into FY 2001, the Space Station Control Center will receive training software loads for the next flights: 6A, 7A, 7A.1, 8A, UF-1 and UF-2. Stand-alone Payload Training Capability (PTC) will be ready in time for flight UF-1 and the Integrated PTC will be readied for the second utilization flight planned for late FY 2001.

Testing and launch site processing activities will continue in FY 2000 to the launches of flights 3A through 7A.1. FY 2000 testing will include Multiple Element Integration Testing (MEIT-2). Planning and processing support activities will begin for flights 9A.1 through 13A, and launch site ground support equipment will be delivered to support active resupply/return flight processing. Operations planning and cargo integration will include processing of stowage accommodations and on-orbit stowage. Processing additional Provisional Inventory Orders for spares, hardware and repair parts will continue. The Super Guppy aircraft will continue to transport very large Space Station elements, and critical spares will be manifested on every Space Station Flight.

Research $455.4 million

The International Space Station is an interactive laboratory in space being built to advance fundamental scientific knowledge, foster scientific discoveries, and accelerate the rate at which it develops beneficial applications derived from long-term, space-based research. There will be many and diverse beneficial applications to life on Earth from this long-term, space-based research. The FY 2001 budget and runout estimates for research are largely unchanged except for the movement of about $10 million a year to the Science, Aeronautics and Technology account to help enable the bioastronautics initiative proposed by OLMSA.

The ISS is configured to maximize the value of human intervention in the experimental process. The astronaut crewmembers will work on experiments with a community of investigators on the ground. Ground-based investigators will also manipulate orbiting experiments through the technologies of telescience, expanding the boundaries of human work in space research. The ISS will be the world's premier facility for studying the role of gravity on biological, physical and chemical systems. The Station will provide the facility and the tools needed to perform unique, long-duration, space-based research in cell and developmental biology, plant biology, human physiology, biotechnology, fluid physics, combustion science, materials science and fundamental physics. The Station also provides a unique platform for making observations of the Earth's surface and atmosphere, the sun, and other astronomical objects, as well as the space environment and its effects on new spacecraft technologies.

As NASA moves into the Space Station era, there will be a major transition from the current limited, short-term on-orbit experimentation program to the long-term research efforts made possible by the capabilities of the ISS. The core of the Space Station research program will be its eight major research facilities:

Gravitational Biology Facility; Centrifuge Facility; Human Research Facility; Materials Science Research Facility (formerly known as the Space Station Furnace Facility); Biotechnology Facility (which includes Protein Crystal Growth apparatus); Fluids and Combustion Facility; Window Observational Research Facility; Low Temperature Microgravity Physics Facility.

In addition to the eight major facilities, NASA will develop common-use laboratory support equipment and Expedite the Processing of Experiments to Space Station (EXPRESS) racks and pallets for the Station.

The Huntsville Operations Support Center (HOSC) will be operational in time to support payload operations for flights 5A.1 and 6A. Flight 5A.1 is likely to be launched in mid-FY 2001, and will continue the outfitting of the U.S. Laboratory with six additional lab system racks and one Human Research Facility (HRF) payload rack. Flight 6A is to be launched in the following quarter and includes two stowage and two EXPRESS payload racks. Payload training and payload integration began in FY 1999 and continues into FY 2000. This includes development of preliminary Interface Control Documents (which specify the standardized way of interfacing to the racks, which in turn interface to the station) and Payload Integration Agreements for payloads aboard 5A.1 and 6A.

During the early phases of ISS Assembly, research will focus on environmental monitoring of the growing Space Station. The capability to conduct on-board research will begin with delivery and outfitting of the Human Research Facility in mid-2001, beginning a new era in human physiological and behavioral research in space. Researchers will use the HRF to expand our understanding of the basic mechanisms of adaptation to living in space for long periods, and to help develop and validate countermeasures to the undesirable effects of space flight. To accommodate this research, NASA will deploy its first four EXPRESS racks on orbit. By late FY 2001 (through UF-1) approximately 6,000 kilograms of research equipment will have been positioned on the Station, transported via the Space Shuttle middeck and inside the Italian Space Agency-supplied Multi-Purpose Logistics Module. Equipment equivalent to some 30 middeck lockers will contain small-scale experiments developed by U.S. businesses and universities. These experiments have been selected based on successful experience with similar small-scale experiments on Mir and the Space Shuttle.

Russian Program Assurance $300.0 million

NASA established the Russian Program Assurance (RPA) budget to provide contingency activities and backup capabilities in response to concerns about the impact of the Russian Government's fiscal problems on meeting their ISS commitments. In spring 1997, NASA embarked on the initial steps of a contingency plan to provide U.S. capabilities to mitigate the impact of further Russian delays. NASA purchased an Interim Control Module (ICM) from the U.S. Naval Research Laboratory to provide attitude control and reboost functions for continuation of the ISS assembly sequence without the Russian Service Module. The ICM is currently being prepared to support a launch as early as December 2000. Provided the Russian Service Module is successfully launched this summer, the ICM could be ready for launch as a back-up propulsion capability 12 months afterwards.

During summer 1998, NASA initiated activities to implement a second step of the contingency plan to provide flexibility for the United States and our international partners in the event of further Russian delays. This consists primarily of building a U.S. propulsion capability, enhancing logistics capabilities, modifying the Shuttle fleet for enhanced Shuttle reboost of ISS, and procurement of Russian goods and services to support Russian schedules for the Service Module, and early ISS Progress and Soyuz launches. NASA believes that this approach, working with Russia to assure near-term critical capabilities while developing independent U.S. capabilities over the long-term, provides the best approach to address the impacts from the Russian economic situation.

Crew Return Vehicle $90 million (Phase 1)

The Russian Soyuz vehicle will provide crew with an emergency way to return to Earth quickly should a life-threatening emergency arise during extended stays on the ISS. However, each Soyuz can only transport a crew of three and requires changing out after about six months on orbit. The Crew Return Vehicle (CRV) project will provide the ISS with an independent U.S. crew return capability for up to seven crewmembers under the following scenarios: if crew members become ill or injured while the space shuttle orbiter is not at the station; or if catastrophic failure of the ISS make it unable to support life and the space shuttle orbiter is not at the station or is unable to reach the station in the required time.

NASA has funded the X-38 project to reduce the risk of developing a CRV. The X-38 design has a strong foundation from the lifting body research and technology developments carried out since the 1960's. The ISS CRV budget estimate provides for the completion of the X-38 project, including a space test flight, and a transition to the Phase 1 development of the CRV. Funding estimates for the Phase 2 production of a CRV are included in the Science, Aeronautics and Technology account, pending a decision on whether to proceed with an X-38-based CRV design, in the context of broader decisions that NASA and the Administration will make regarding future space transportation architectures. A design decision on whether to follow the X-38 path or to incorporate alternative design concepts will be made within two years.

II. Space Shuttle Program - $3,165.7 million

The Space Shuttle continues to be the most versatile launch vehicle ever built. The scope of its 96 missions has demonstrated this. Among the program's accomplishments are: rendezvous missions with the Russian Space Station Mir; advancement of life sciences and technology through long-duration Spacelab and Spacehab missions; and repair and servicing of the Hubble Space Telescope, enabling discovery of new astronomical phenomena. The Space Shuttle has also performed rescue and retrieval of spacecraft, and is key to the assembly of the International Space Station. The Space Shuttle Program services numerous cooperative and reimbursable payloads involving foreign governments and international agencies. The current focus of international cooperation, for which the Space Shuttle is uniquely suited, is the assembly and operational support of the International Space Station (ISS), begun in FY 1999.

The primary goals of the Space Shuttle program in priority order are: (1) fly safely; (2) meet the flight manifest; (3) improve supportability, and (4) improve the system. Reduction in program costs is a continuing program objective made possible by accomplishment of these four goals.

The flight rate for the program continues to be budgeted at an average of seven flights per year with a surge capability to eight flights. In FY 1999, the Space

Shuttle Program launched four flights including the reflight of the Spartan payload and a series of experiments by the National Institute on Aging with the return to space of Senator John Glenn. The Space Shuttle Program also began the assembly of the International Space Station and deployed the last of the "Great Observatories" when it launched the Advanced X-Ray Astrophysics Facility, named "Chandra." A maximum of six flights is planned for FY 2000 and nine flights for FY 2001.

The Space Shuttle budget structure consists of four major components: flight Hardware ($2,005.9M), Ground Operations ($551.8M), Flight Operations ($273.6M), and Program Integration ($334.4M).

Within the four categories reside supportability upgrades to develop systems to combat obsolescence of vehicle and ground systems in order to maintain the program's viability into the next century. Vendor loss of aging components, high failure rates of older components, high repair costs of Shuttle-specific devices, and negative environmental impacts of some out-dated technologies are being addressed

In addition, this budget request provides for additional safety upgrades that will improve reliability and ensure continued safe operations of the system into the next century. Examples include the Electric Auxilliary Power Unit improvements in the Orbiter and Solid Rocket Booster system to replace hydraulics and old technology; advanced health monitoring of the Space Shuttle Main Engines and studies for upgrading the avionics and cockpit areas of the Orbiter to provide for reduced crew procedures during ascent. The priorities of the upgrades will be determined by an external, independent review panel. The upgrades are targeted to be implemented by 2005.

The Space Flight Operations Contract performed by United Space Alliance continues to comprise almost one-half of the budget and will increase in size as more contracts are consolidated.

III. Payload and ELV Support - $90.2 million

The Payload and ELV Support budget consists of two major projects - Payload Carriers and Support and Expendable Launch Vehicles Mission Support

The Payload Carriers and Support budget supports the processing and flight of Space Shuttle. This includes the processing of unpressurized carriers, Get-Away Special, Hitchhiker, and Flight Support System carriers in this budget. Activities funded by this budget support the required technical expertise and facilities to perform the payload buildup, test and checkout, integration, servicing, transportation and installation into the Shuttle launch vehicle. In FY 1999, launch and landing payload support activities were provided for four Space Shuttle missions, including the first American segment of the ISS, and payload processing support activities and facilities for six manifested major payloads. In FY 2000, launch and landing payload support activities will be provided for six Space Shuttle missions including the Hubble Space Telescope (HST-03A) launch, the Shuttle Radar Topography Mission (SRTM) launch, and four assembly flights for the ISS. In FY 2001, launch and landing payload support activities will be provided for nine Space Shuttle missions, including seven ISS assembly and utilization flights. During this period, five pallets will be used in Space Shuttle missions, including the fourth HST servicing mission and three of the ISS assembly flights. In FY 2000 and 2001, over 20 major and secondary payloads will be supported, including major hardware for ISS assembly.

The Expendable Launch Vehicle (ELV) Mission Support budget provides funds for all NASA missions requiring flight on ELVs. Advanced mission design/analysis and leading edge integration services are provided for the full range of NASA missions under consideration for launch on ELVs. During FY 1999, 9 ELV launches and 1 secondary ELV mission were successfully launched. Support for 13 missions, including Tracking and Data Relay Satellite-H (TDRS-H), Terra and Geostationary Operational Environmental Satellite-L (GOES-L), are planned for launch in FY 2000. Integration and technical management of 28 payloads are planned for launch in FY 2000 and FY 2001. Support for 11 missions and 1 secondary payload is planned for FY 2001.

Investments and Support - $129.5M

Beginning in FY 2001, a new Human Exploration and Development of Space (HEDS) Technology and Commercialization Initiative will include human space exploration and development activities emphasizing highly innovative technologies, advances in science, and enabling synergistic commercial space development efforts.

Also a consolidated project activity will begin in FY 2001 to ensure NASA's rocket propulsion test capabilities are properly managed and maintained in world class condition. The project will significantly enhance our ability to properly manage NASA's rocket testing activities and infrastructure across all four participating NASA centers.

Engineering and technical base (ETB) activity will continue to support the institutional capability in the operation of space flight laboratories, technical facilities and testbeds; to conduct independent safety and reliability assessments; and to stimulate science and technical competence in the United States. Also, funding to support additional academic program activities is provided in this budget

Space Shuttle Missions

Nine flights are planned during FY 2001, including seven ISS assembly and servicing missions. In addition, a dedicated microgravity research flight and another HST Servicing Mission (3B) will be flown.

IV. Space Operations Program: $529.4 million

The Space Communications program provides command, tracking, and telemetry data services between ground facilities and flight mission vehicles. It also provides all the interconnecting telecommunications services to link together the following:

tracking and data acquisition network facilities

mission control facilities

data capture and processing facilities

industry and university research and laboratory facilities, and

investigating scientists

The program provides scheduling, network management and engineering, pre-flight test and verification, and flight mission maneuver planning and analysis. It also manages NASA's spectrum utilization issues, and data standards coordination. The program goal is to provide integrated solutions to operational communications and information management needs common to all NASA strategic enterprises.

Mission and Data Services are provided to a large number of NASA missions including planetary and interplanetary missions; human space flight missions; near-earth and earth orbiting missions; research aircraft missions, and sub-orbital flights. These services are provided by NASA's Space Network, Deep Space Network, Ground Network, Integrated Services Network, and Mission Control and Data Systems facilities.

The Space Operations Program budget structure consists of four components:

Operations ($329.8 million)

Mission and Data Services Upgrades ($106.2 million)

Tracking and Data Relay Satellite System Replenishment ($55.0 million)

Technology ($38.4 million).

The program is managed by the Space Operations Management Office (SOMO), located at NASA's Johnson Space Center, Houston, Texas. SOMO manages the telecommunications, data processing, mission operations, and mission planning services to meet NASA's goal in an integrated and cost-effective manner. One SOMO objective is to encourage commercialization of NASA's operations services. Another is to participate with NASA's strategic enterprises in collaborative interagency, international, and commercial initiatives. SOMO also seeks opportunities for using technology in pursuit of more cost-effective solutions, highly optimized designs of mission systems, and advancement of NASA's and the nation's best technological and commercial interests.

NASA is continuing to consolidate and streamline major support contract services consistent with the National Space Policy directive to privatize or commercialize space operations activities no later than 2005. A Consolidated Space Operations Contract (CSOC) was successfully implemented by SOMO and Lockheed Martin on January 1, 1999. The CSOC provides end-to-end mission and data services to both NASA and non-NASA customers. A total of nine contracts were consolidated at inception, and four more have been consolidated in FY 2000 to date, with two additional contracts to be consolidated in FY 2001. In addition, management responsibility for all Wide Area Network data distribution services for all crewed, earth orbiting, and deep space missions was successfully outsourced by CSOC in FY 2000.

Development activities for the TDRS Replenishment Spacecraft continue to progress. NASA now plans to launch the first spacecraft in the series, TDRS-H, in June 2000, and continue processing TDRS I and J. Launch of TDRS I is currently scheduled for FY 2002, and launch of TDRS-J is planned for FY 2003.

February 2000